Canary in the watershed

Identifying drought indicators that best predict regional water shortages

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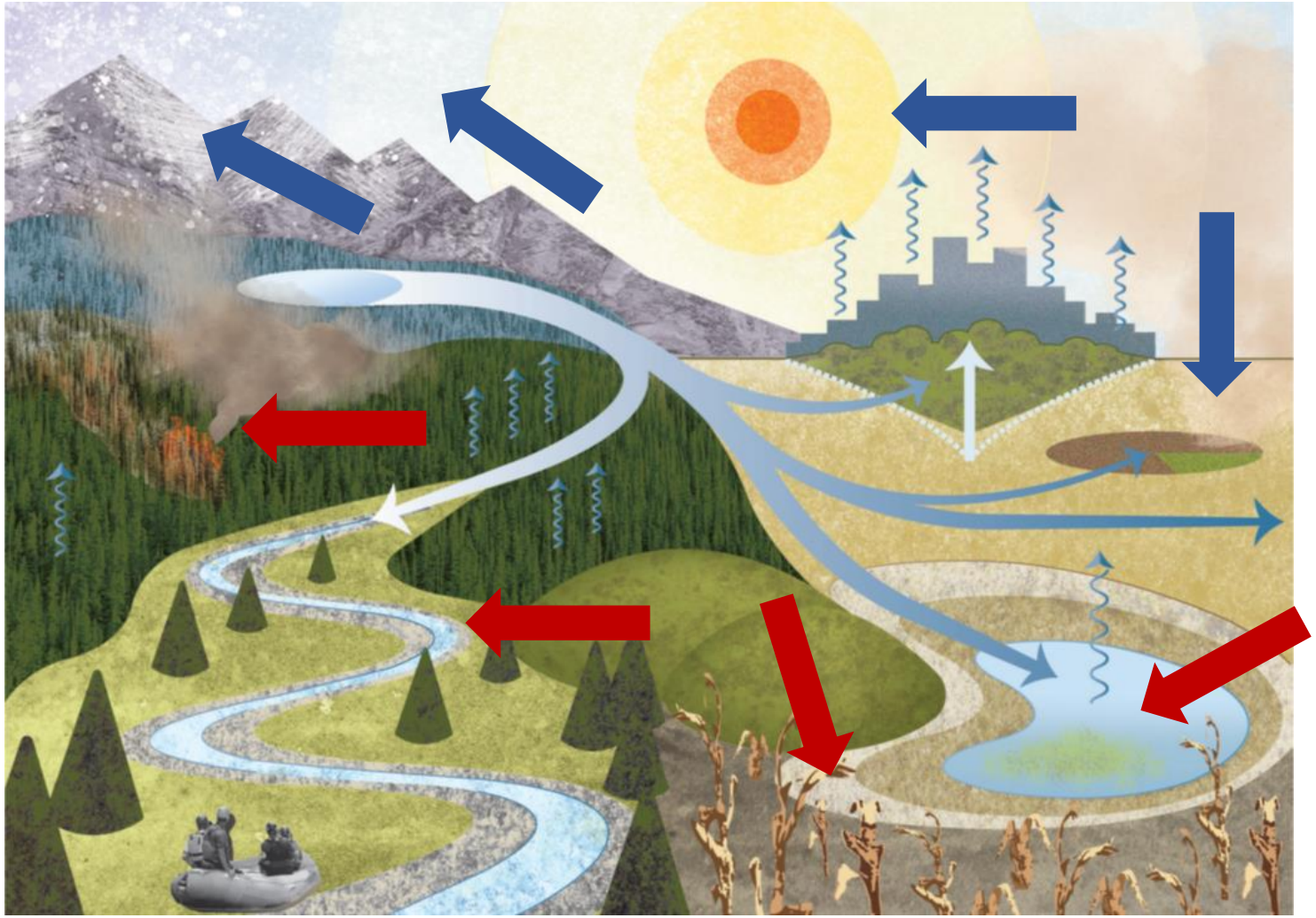
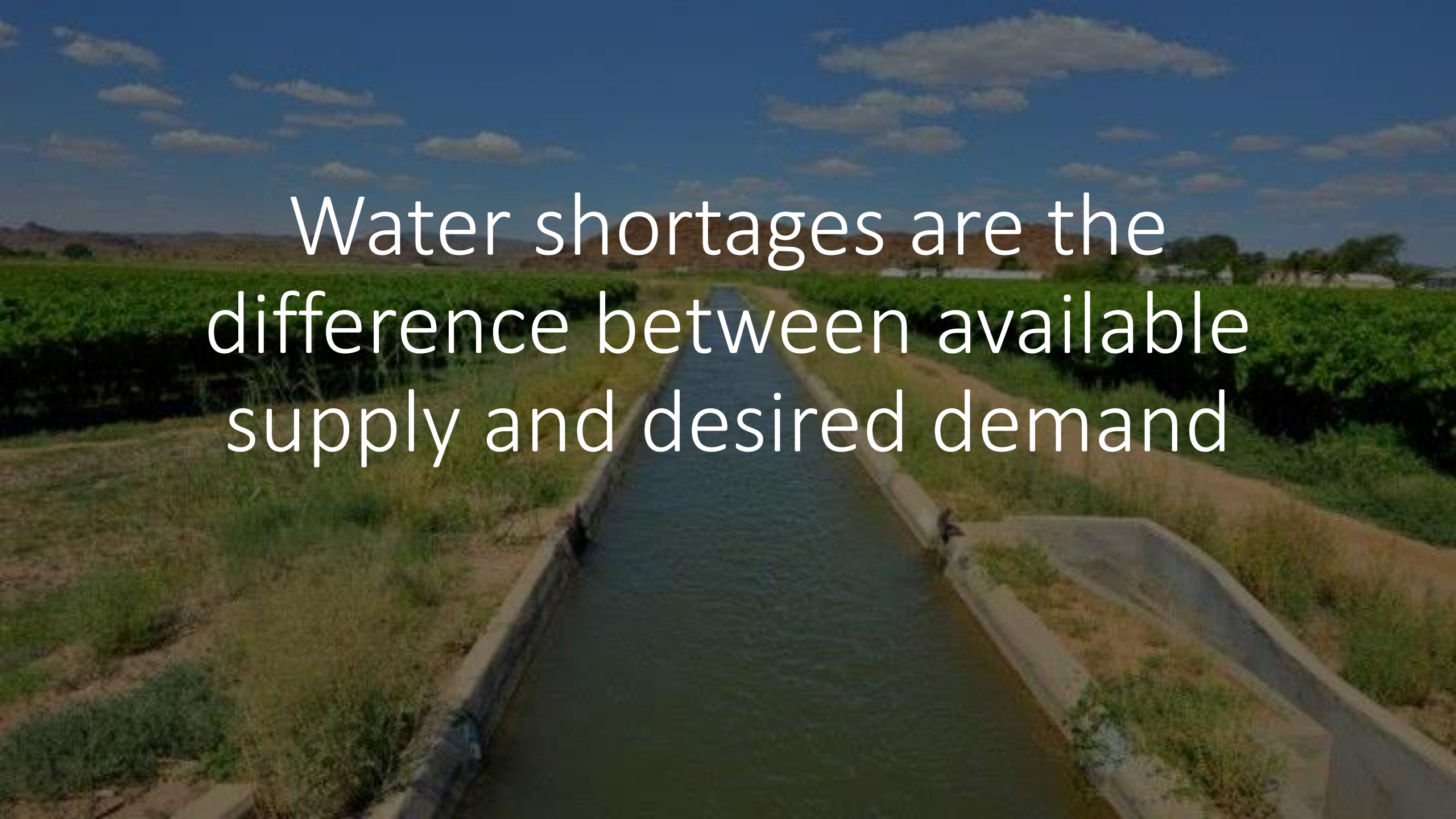
Droughts are defined by:

- climate conditions
- impacts




Water shortages are the difference between available supply and desired demand

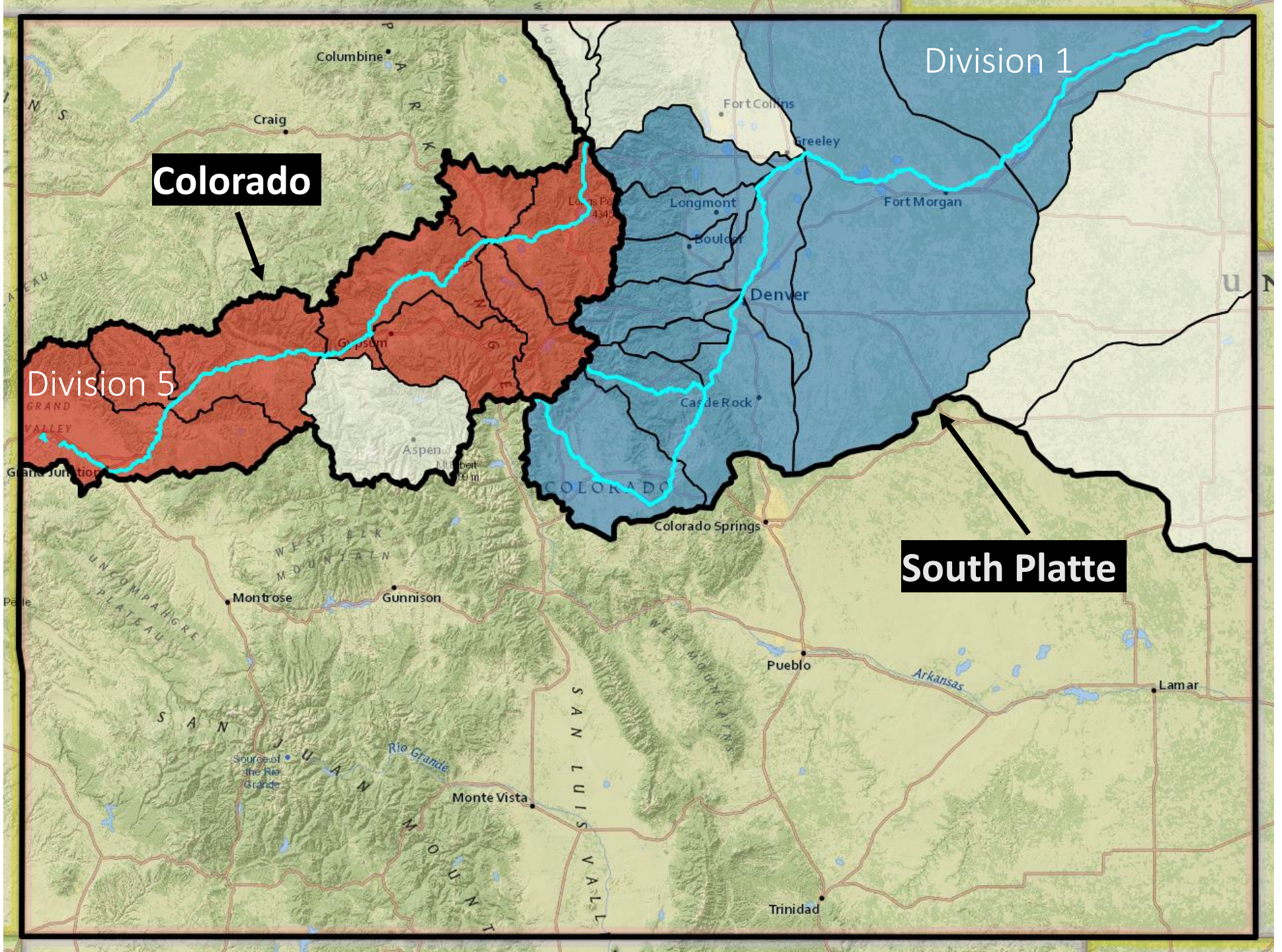
The cascade of economic and social impacts of water shortages can be minimized if regional water availability can be predicted

Questions:

Which drought indicators best predict reduced water availability?

How does drought sensitivity vary across Colorado?

How will climate change affect water shortages in the future?

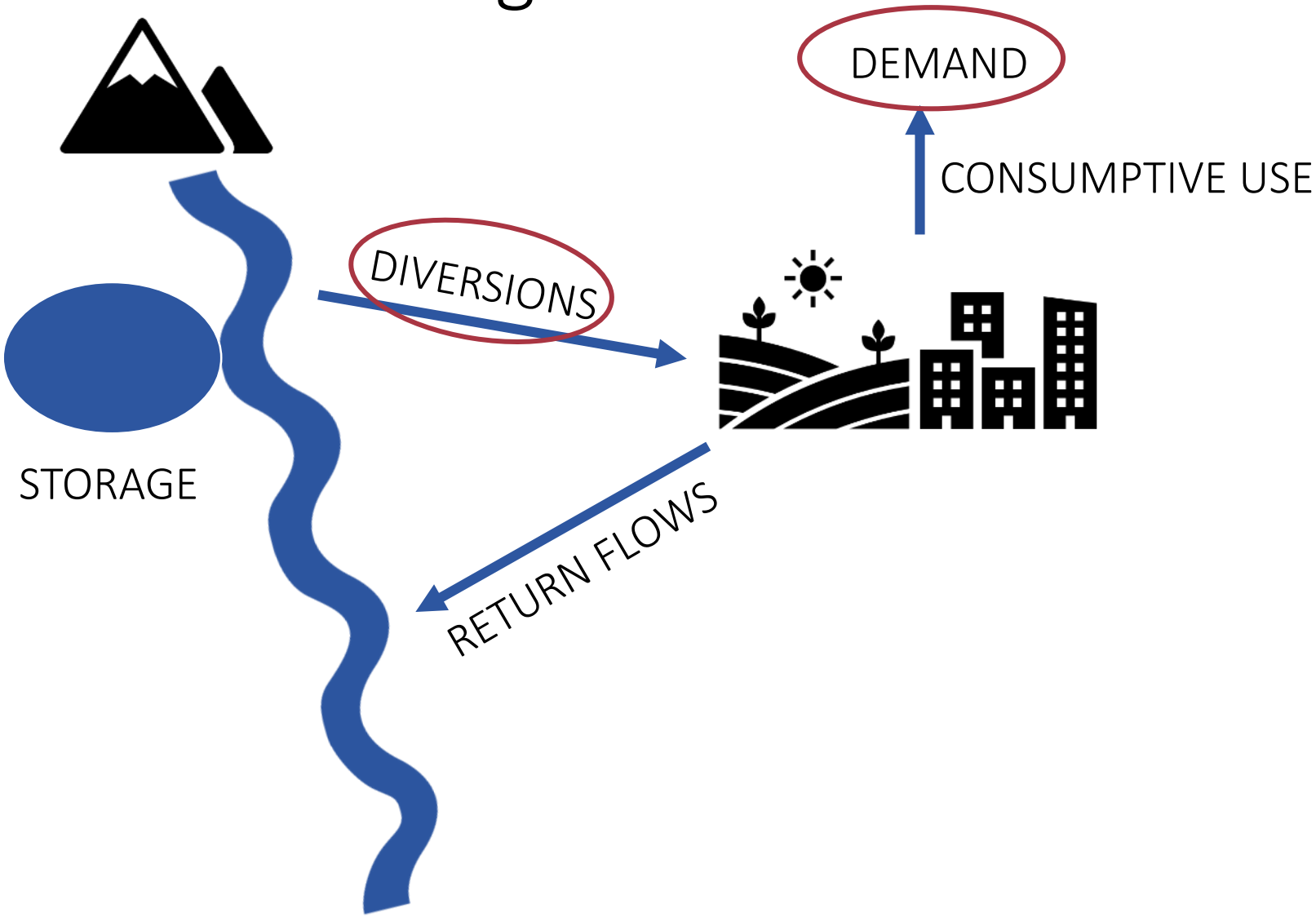

Division 1
Colorado
Division 5
South Platte
Columbine
Craig
Fort Collins
Greeley
Longmont
Fort Morgan
Boulder
Denver
Castle Rock
Aspen
Colorado Springs
Montrose
Gunnison
Pueblo
Lamar
Arkansas
Rio Grande
Source of the Rio Grande
Monte Vista
Trinidad
COLORADO

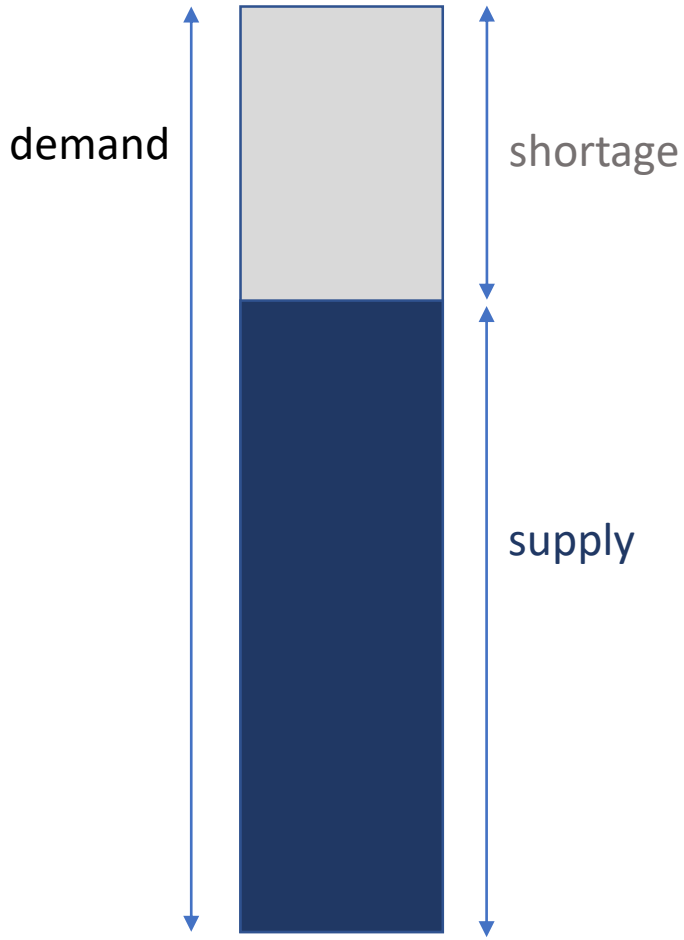
Data

Water supply and allocation data

Climate data

Statemod is a model of human water management activities





Total Shortage = demand - supply

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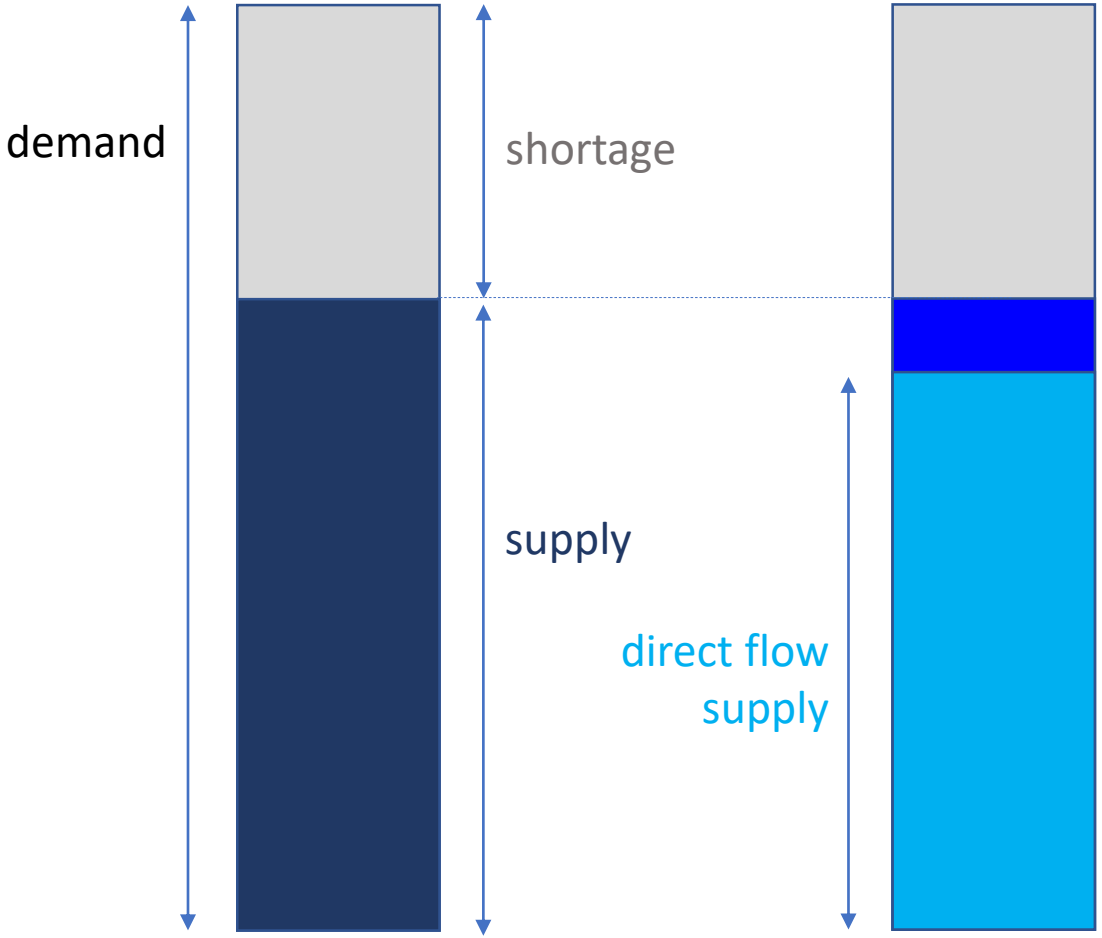
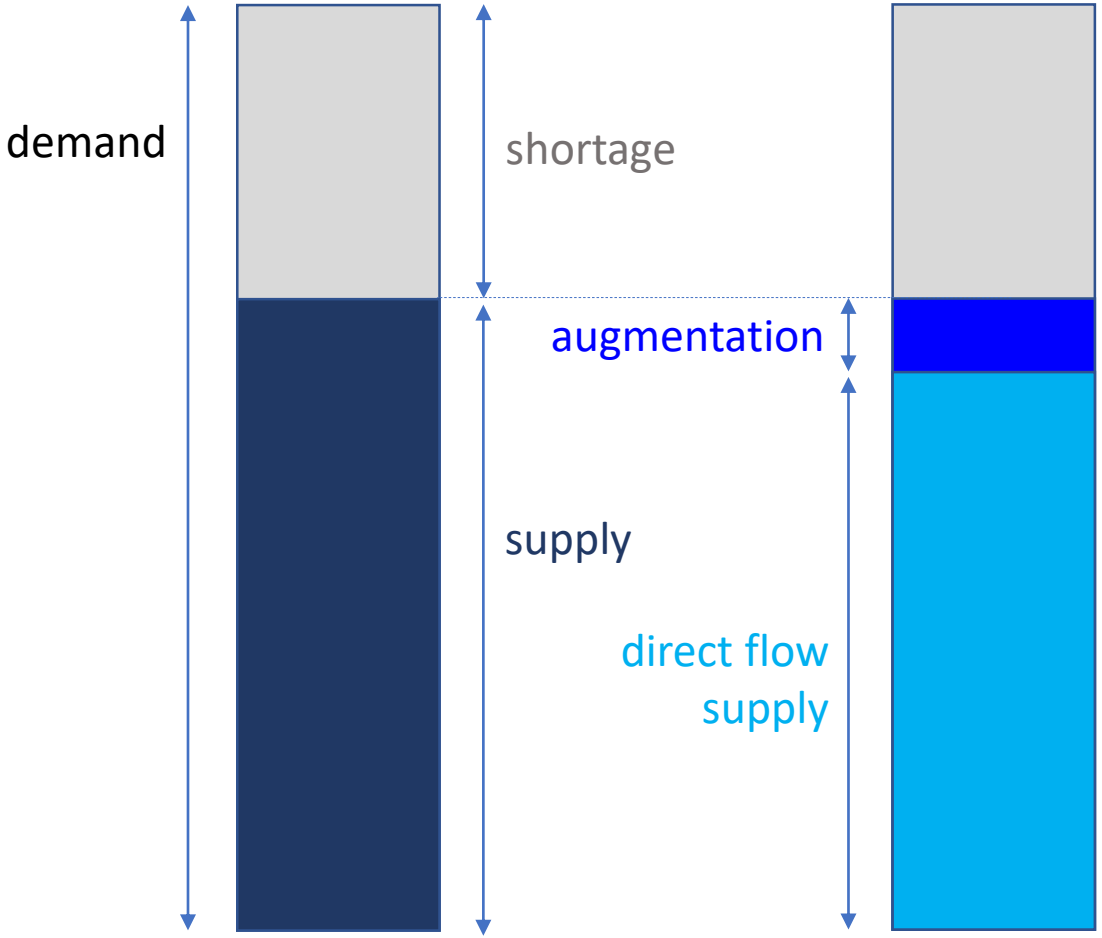
Supply = direct flow



Total Shortage = demand - supply

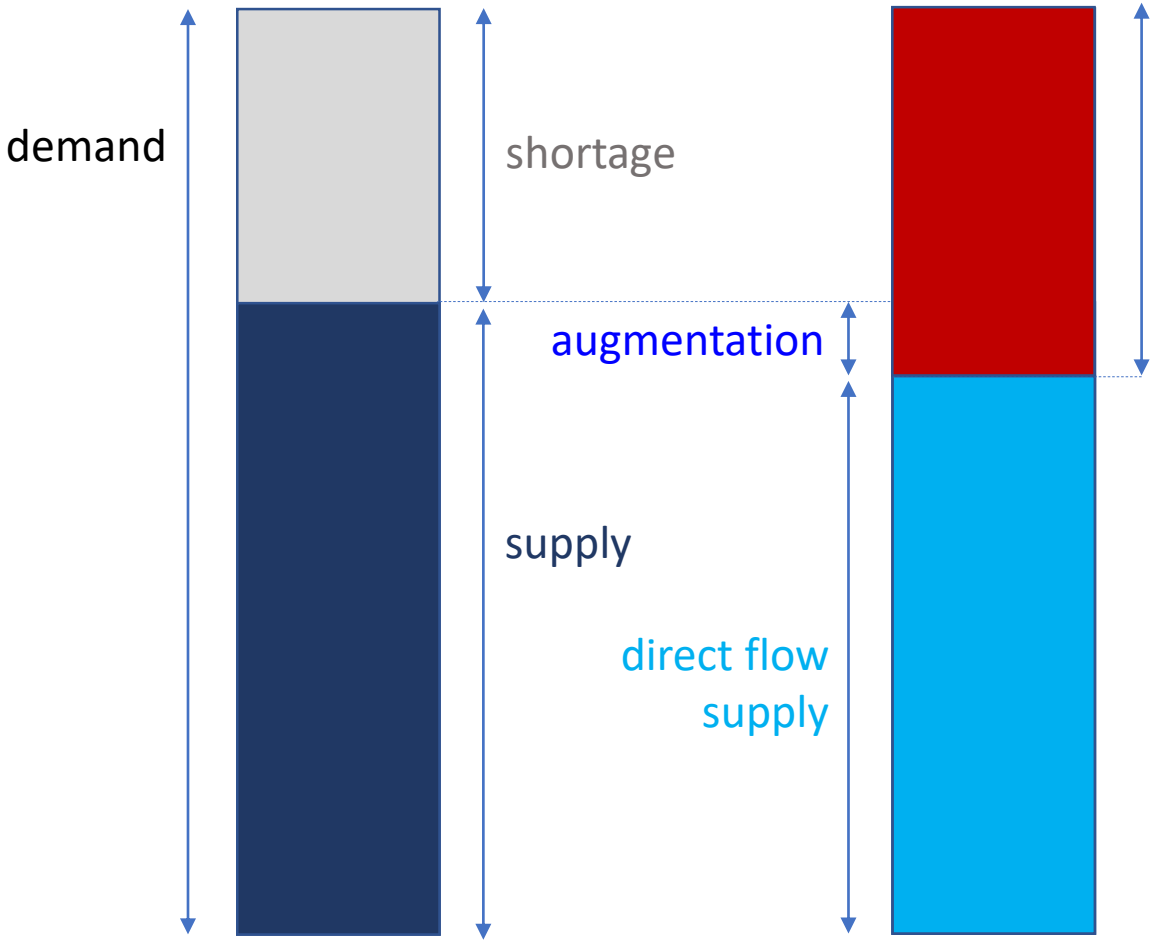
Supply = direct flow + augmentation

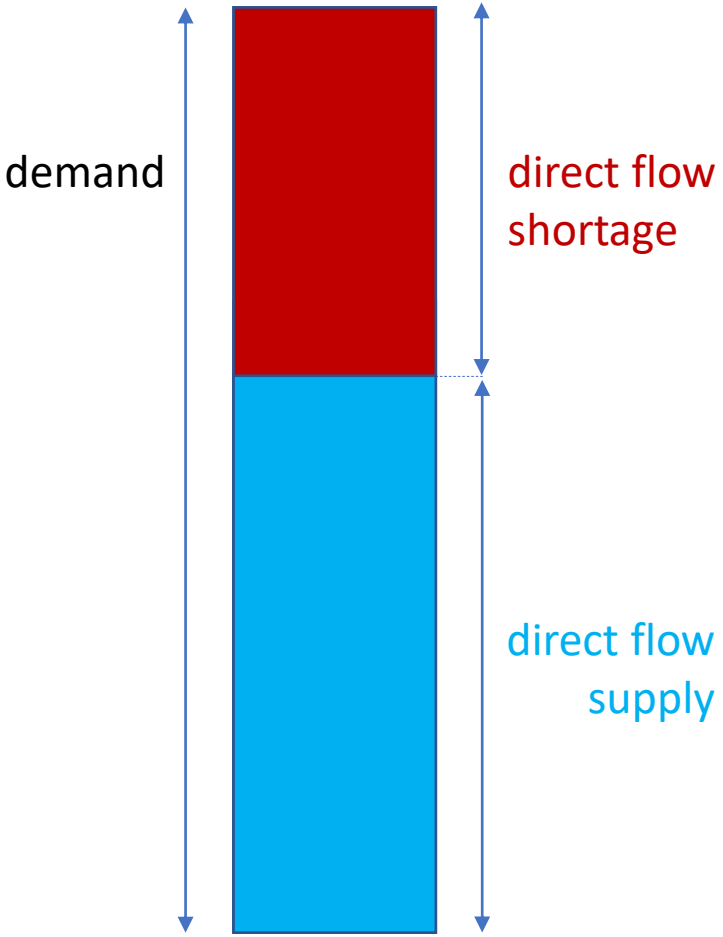


Total Shortage = demand - supply

Supply = direct flow + augmentation

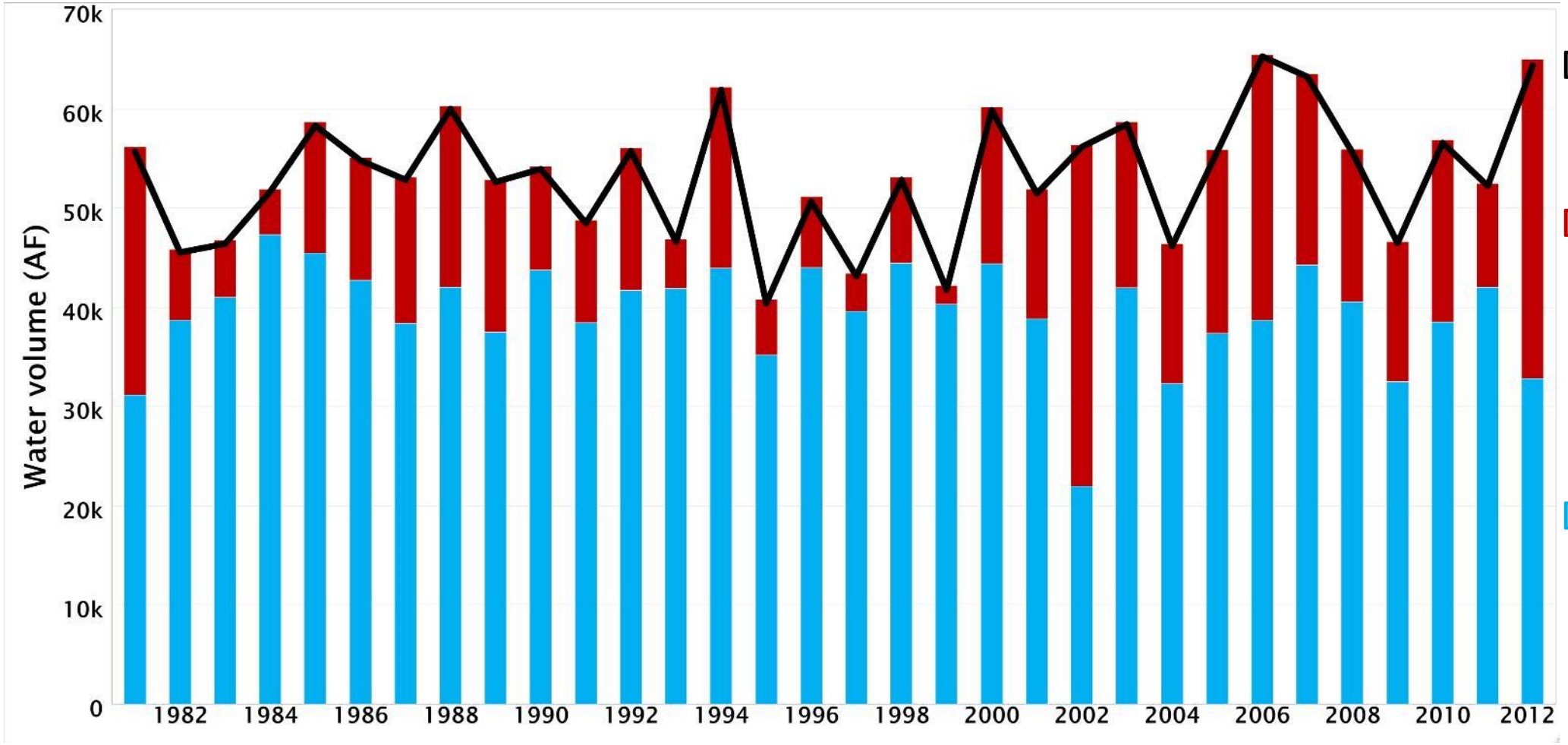
Direct flow shortage = demand - direct flow





Direct flow shortage = demand - direct flow

Statemod generates estimates of demand, supply, and shortage (e.g. District 6 – Boulder Creek)



Demand*

Direct flow shortage

Direct flow supply

* Fixed acreage and variable ET

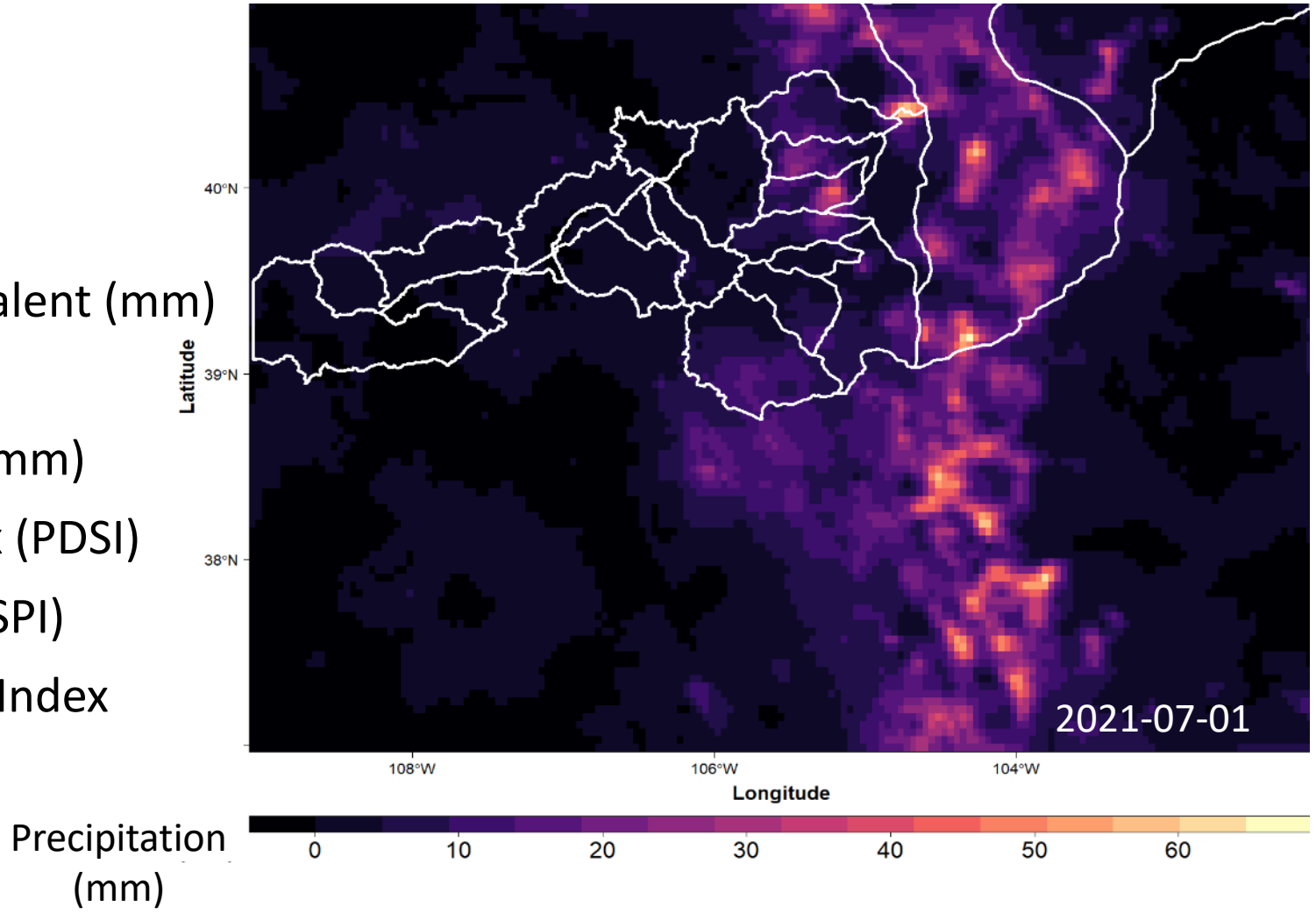
Data

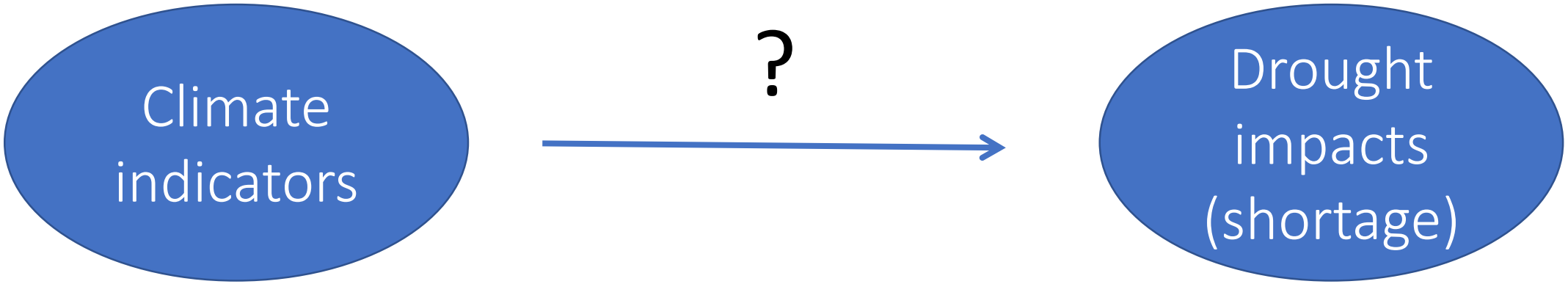
Water supply and allocation data

Climate data

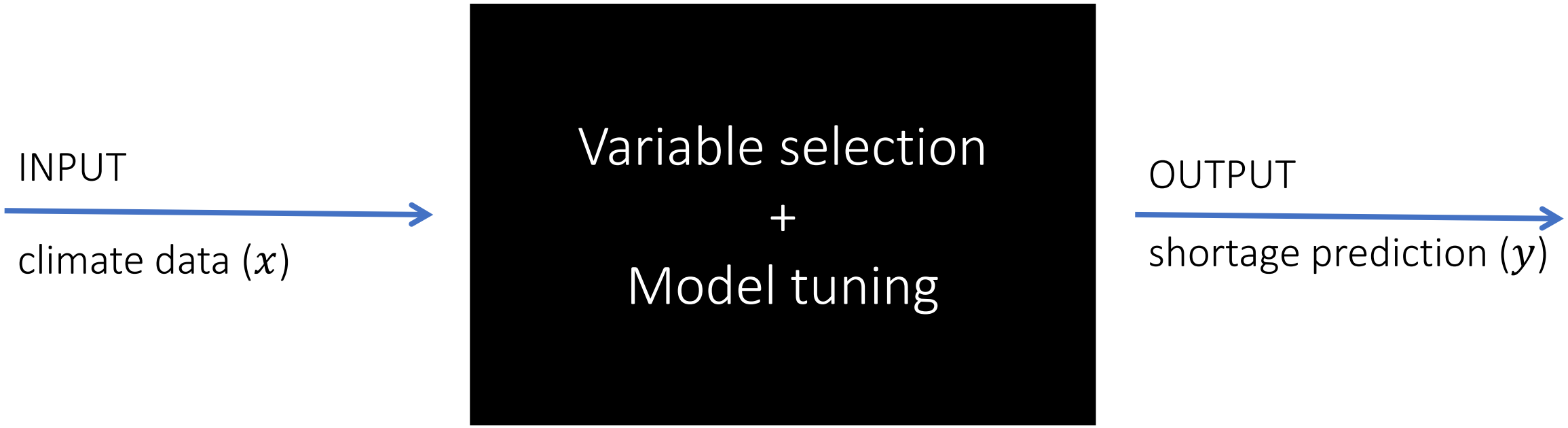
Climate Data

- Precipitation (mm)
- Temperature (C)
- Springtime Snow Water Equivalent (mm)
- Soil moisture (mm)
- Potential Evapotranspiration (mm)
- Palmer Drought Severity Index (PDSI)
- Standard Precipitation Index (SPI)
- Evaporative Demand Drought Index (EDDI)




Climate indicators
?
Drought impacts (shortage)

Drought Sensitivity Model



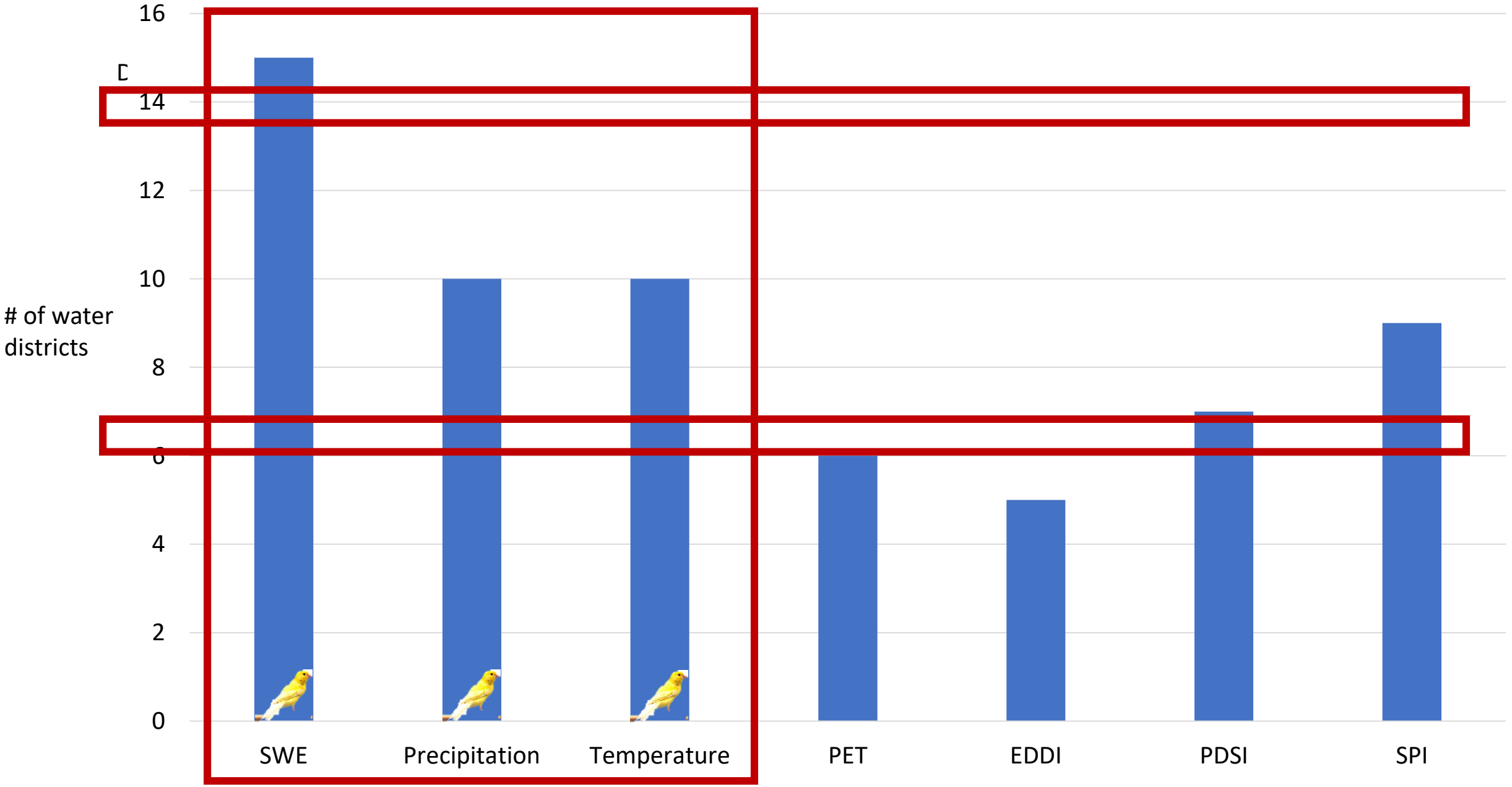
$$y = \beta_0 + \beta_1 x_1 + \cdots + \beta_n x_n + \varepsilon$$

1. Which drought indicators best predict reduced water availability?

2.

3.

District drought sensitivity models are unique for each water district, but trends exist



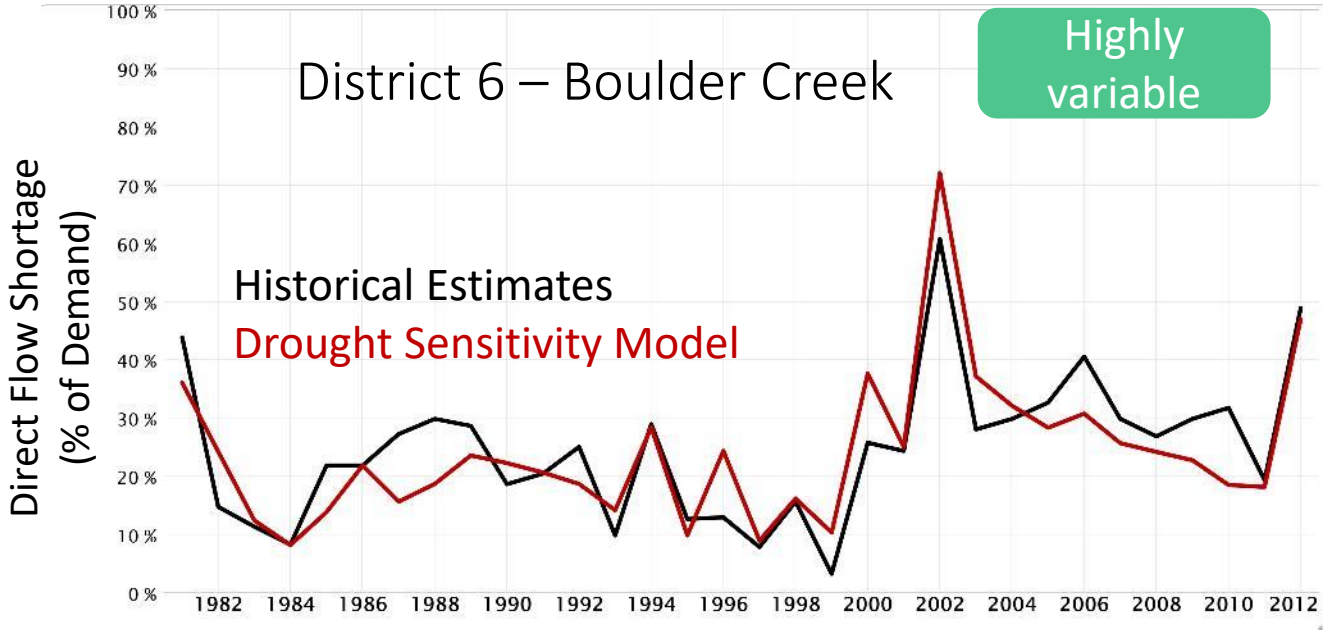
1. Which drought indicators are the best predictors of water availability?

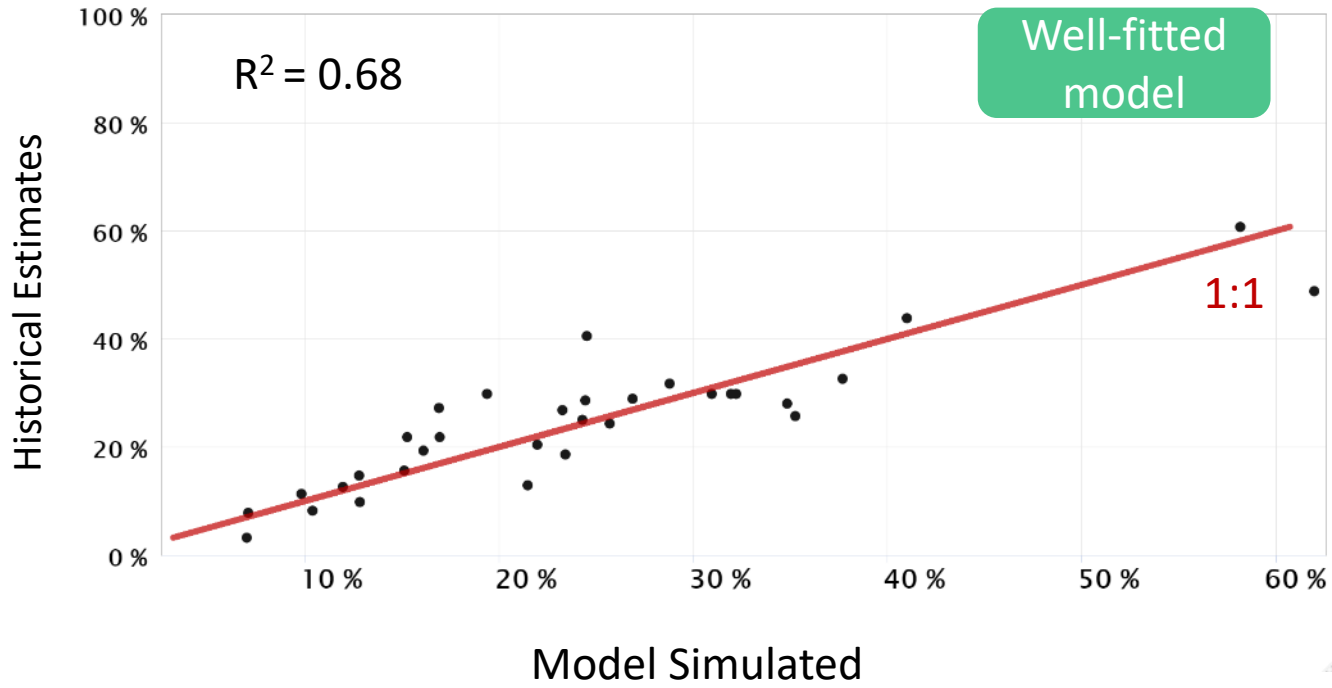
SWE, precipitation, and temperature are dominant drought indicators across all water districts

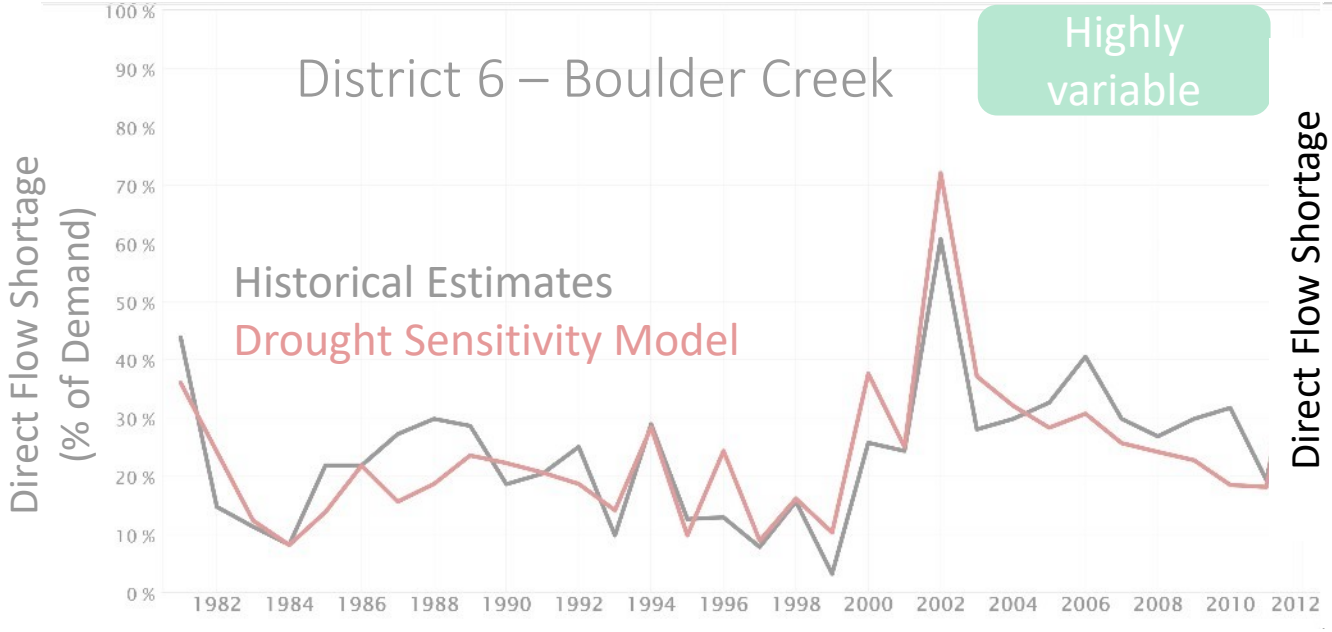
1.

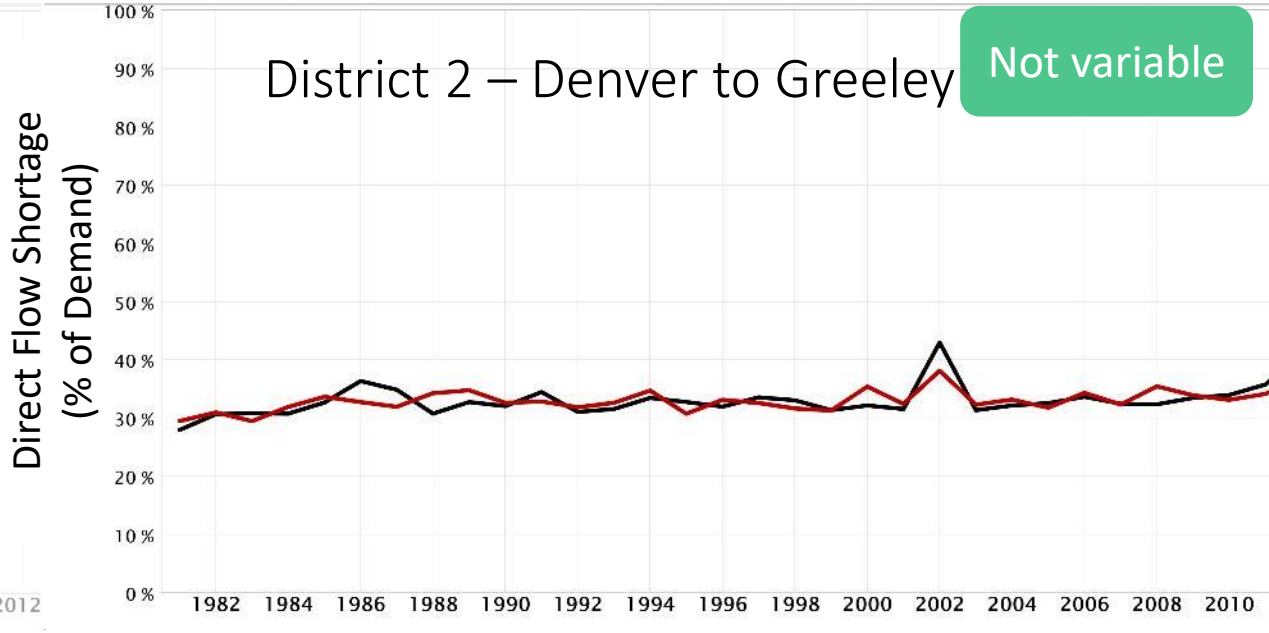
2. How does drought sensitivity vary across Colorado?

3.

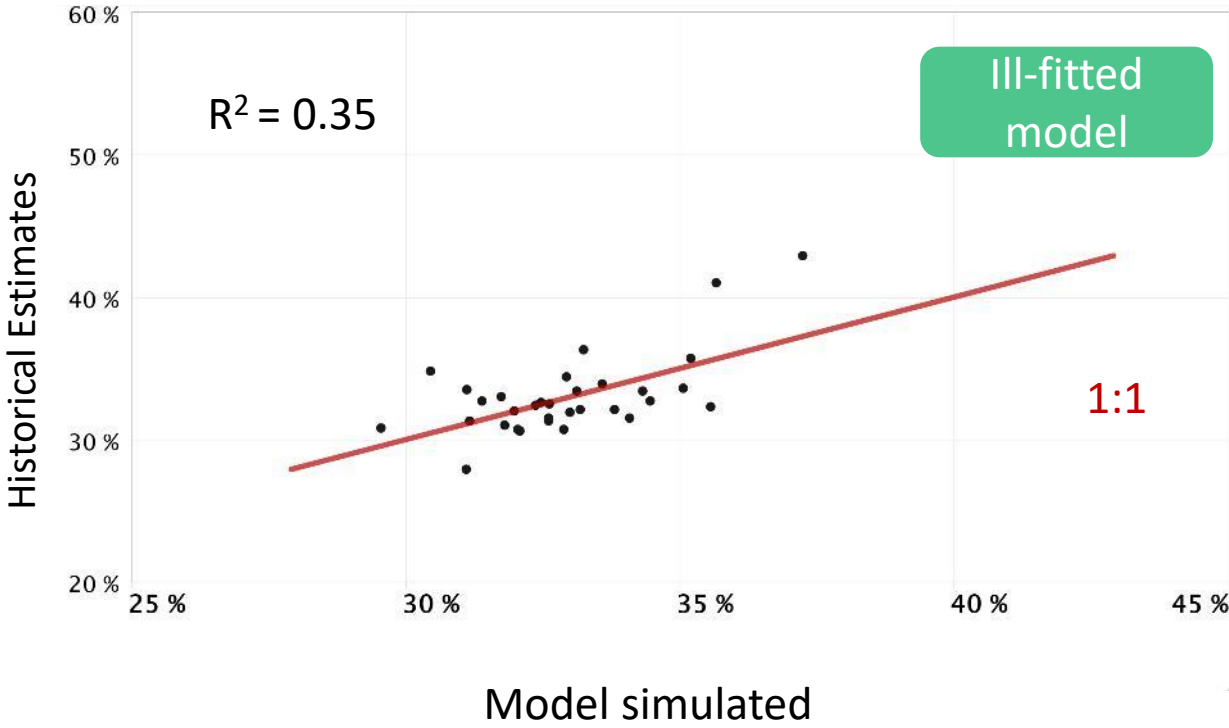

District 6 – Boulder Creek
Highly variable
Historical Estimates
Drought Sensitivity Model
Direct Flow Shortage (% of Demand)
100 %
90 %
80 %
70 %
60 %
50 %
40 %
30 %
20 %
10 %
0 %
1982 1984 1986 1988 1990 1992 1994 1996 1998 2000 2002 2004 2006 2008 2010 2012


R^2 = 0.68
Well-fitted model
1:1
Historical Estimates
Model Simulated
100 %
80 %
60 %
40 %
20 %
0 %
10 %
20 %
30 %
40 %
50 %
60 %

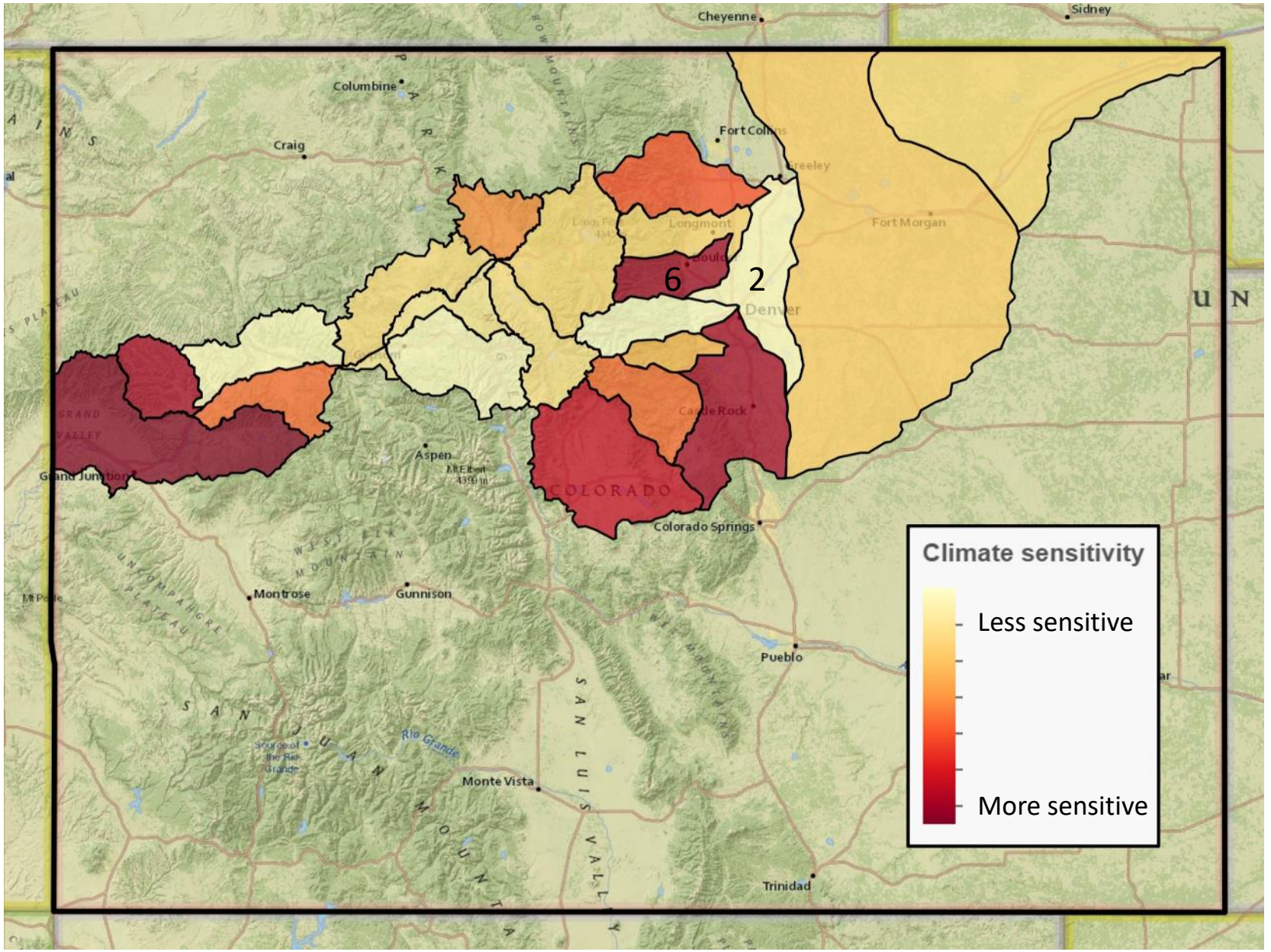

District 6 – Boulder Creek
Highly variable
Historical Estimates
Drought Sensitivity Model
Direct Flow Shortage (% of Demand)
100 %
90 %
80 %
70 %
60 %
50 %
40 %
30 %
20 %
10 %
0 %
1982 1984 1986 1988 1990 1992 1994 1996 1998 2000 2002 2004 2006 2008 2010 2012


District 2 – Denver to Greeley
Not variable
Direct Flow Shortage (% of Demand)
100 %
90 %
80 %
70 %
60 %
50 %
40 %
30 %
20 %
10 %
0 %
1982 1984 1986 1988 1990 1992 1994 1996 1998 2000 2002 2004 2006 2008 2010


R^2 = 0.68
Well-fitted model
1:1
Historical Estimates
100 %
80 %
60 %
40 %
20 %
0 %
10 %
20 %
30 %
40 %
50 %
60
Model simulated


R^2 = 0.35
Ill-fitted model
1:1
Historical Estimates
60 %
50 %
40 %
30 %
20 %
25 %
30 %
35 %
40 %
45 %
Model simulated

Climate sensitivity is an index that can synthesize variability and fit



2. How does drought sensitivity vary across Colorado?

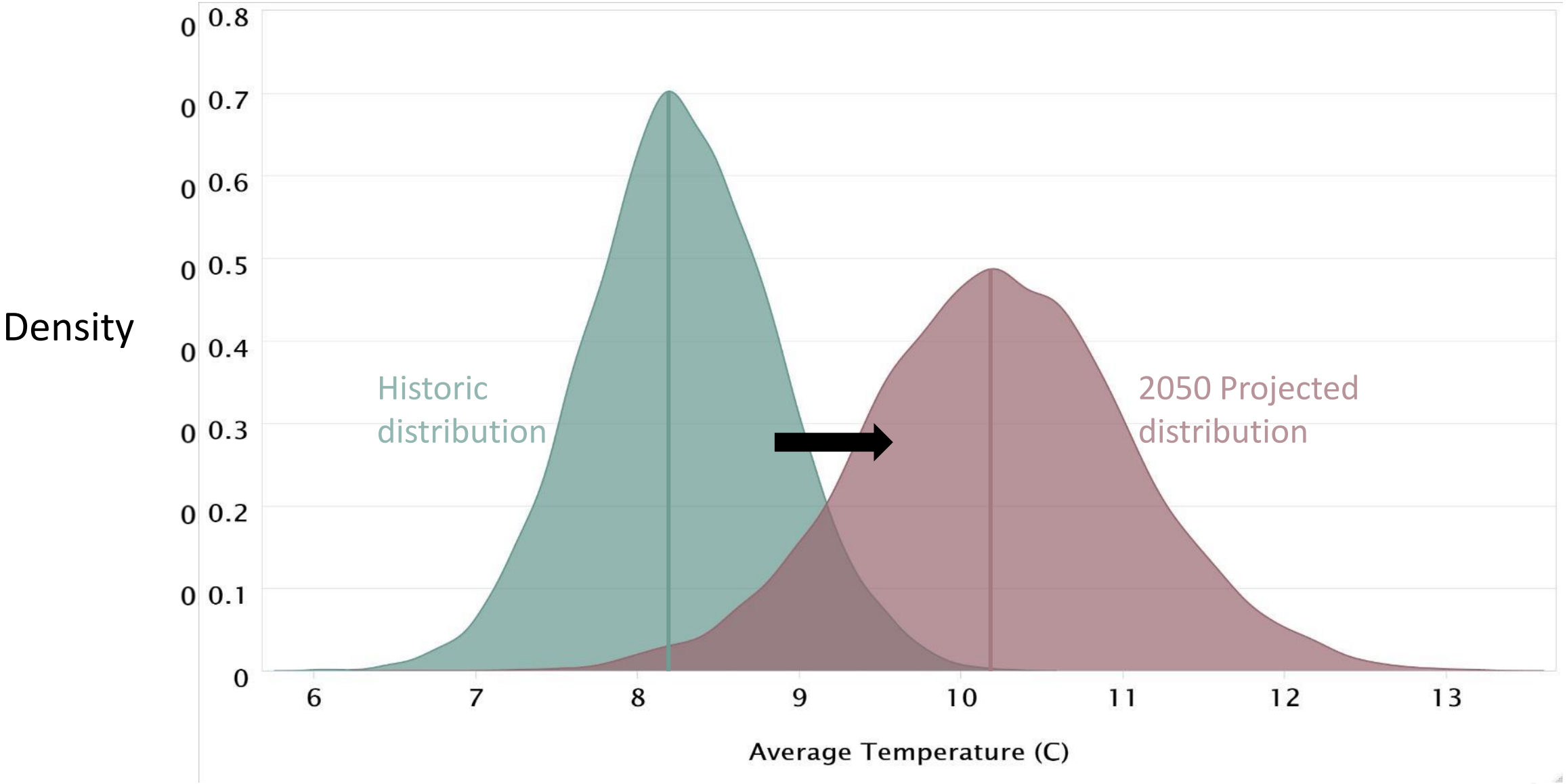
Districts respond differently to drought even within the same watersheds

1.

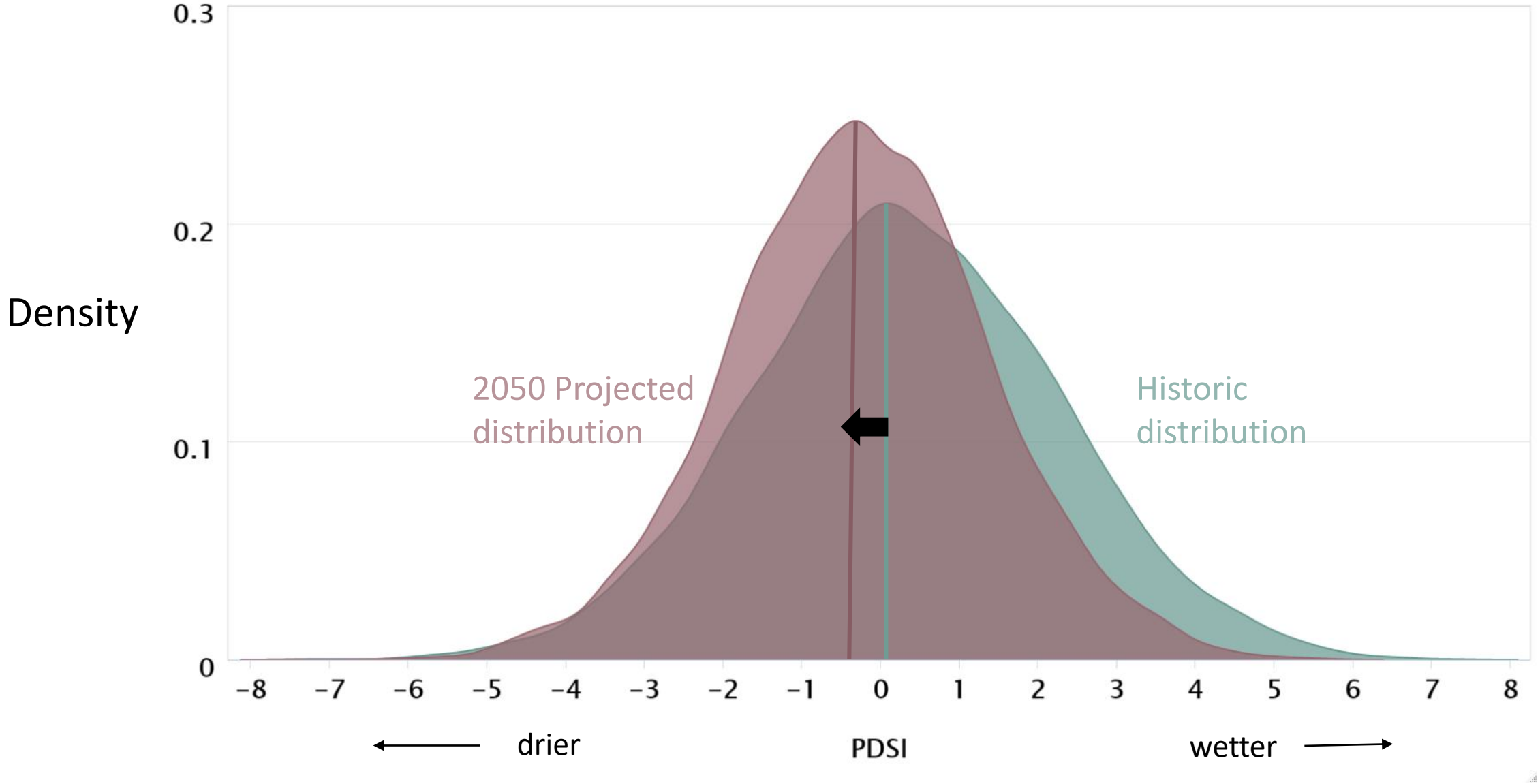
2.

3. How will climate change affect water shortages in the future?

Temperature – Boulder Creek

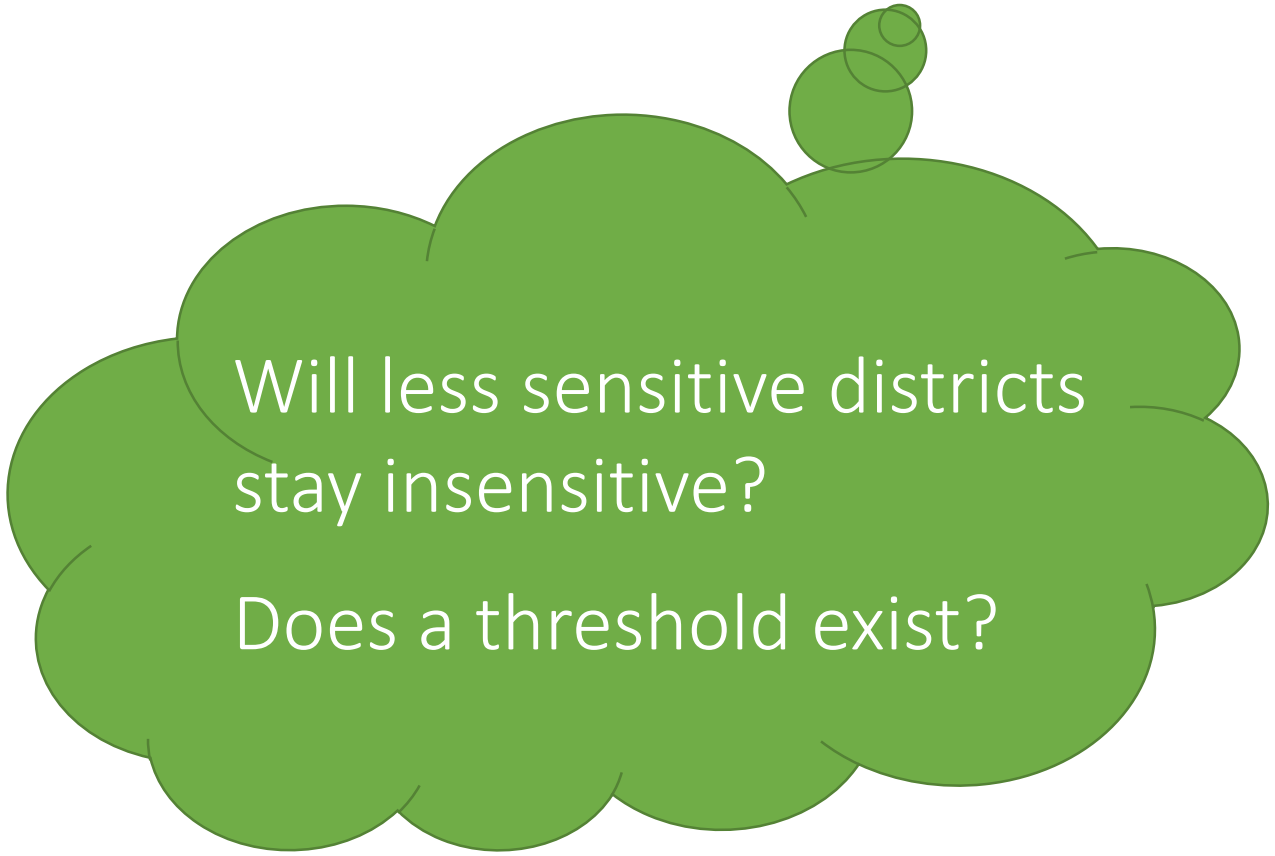


PDSI – Boulder Creek



3.

How will climate change affect water shortages in the future?



Key Takeaways

1. Water managers and users need to discern which of many drought indicators best predict regional water availability

2. SWE, precipitation, and temperature are dominant indicators of drought

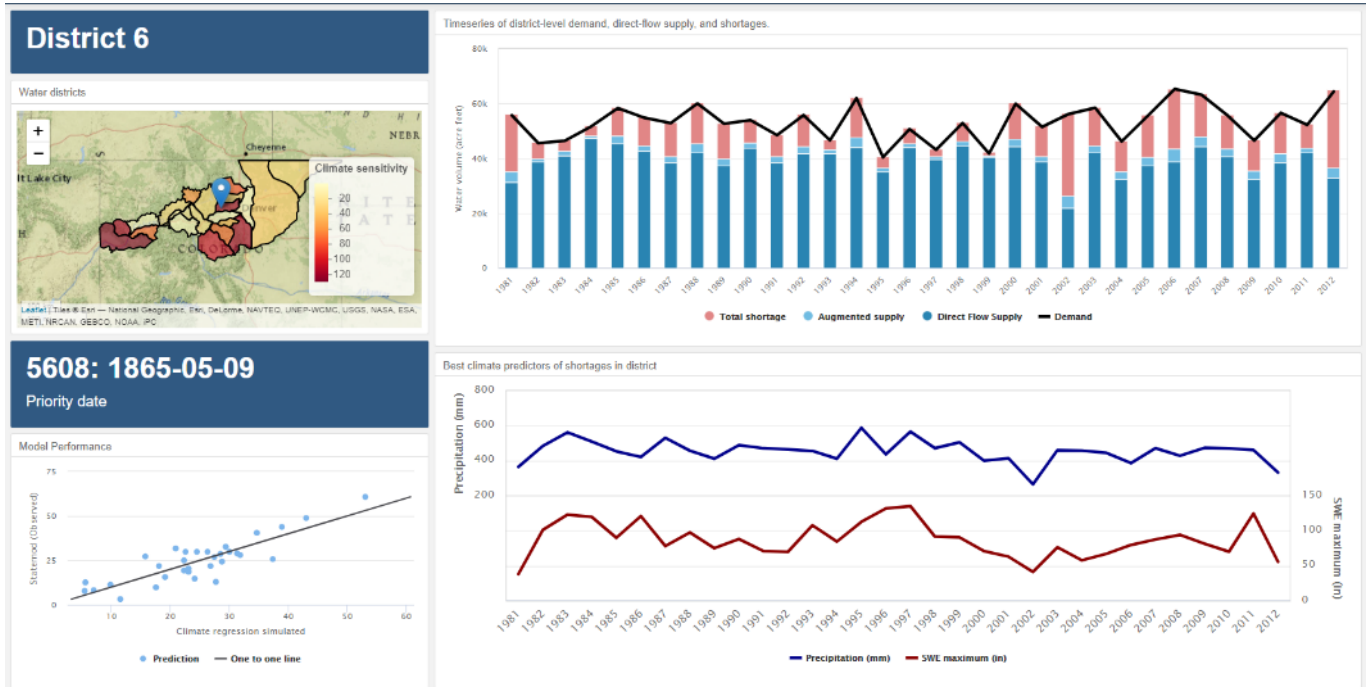
3. Some districts are more sensitive to drought conditions than others, even within the same watersheds

Lynker

To explore our analysis interactively, checkout the dashboard here

https://bit.ly/climate-canaries

(in development)



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